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SYSTEMATIC SCHOOL ROBOTICS EDUCATION

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Abstract

The development of robotics, requires more and more high-skill professionals in various fields of knowledge. This article is devoted to training organization of such specialists in schools with the purpose of their further education at the university. From the experience of the work of the robotics sections of the Kuban State University for schoolchildren in Krasnodar. It follows that too much involvement of students in robotics may not yield a very positive impact on their further professional career. Further, the reasons for this phenomenon and ways to organize a system-based school robotics education that would allow maximally reveal the potential of high school students to obtain various professional specialties in the direction of robotics are discussed. The analysis of the personnel requirements of the robotics industry is made. For each specialty, recommendations are given on the preparation of professional skills elements within the school education process. In addition, for the successful preparation of high school students, it is extremely important to combine classes in robotics with classes in mathematics, physics, mechanics and electronics. With the right combination of lessons, high school students becoming students better and more successfully master their chosen specialties. It is also important that they engage in projects related to robotics. The school experience may have a decisive influence on the choice of the future profession for students.

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Keywords: Robotics, education, advance learning, high-skill professional.

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1. Introduction

Robotics as applied science includes the developing of mechanisms design and the programming of motion algorithms. If we consider robotics as an industry, then we have to add the process of assembling mechanisms and debugging their work. Robotics as an industry is quite a new phenomenon and requires for its development the attraction of a large number of specialists of various qualifications.

This is justified by the rapid growth of the robotics industry. The issue of training such specialists and retraining other fields specialists is acute. Moreover, both theoretical specialists, capable of putting forward fresh ideas, as well as "technicians" who are important team players capable of working directly with hardware are in demand. Before, robotics was mainly run by large states e.g. space industry. Nowadays these technologies are increasingly used in everyday life. Jobs are in the companies for the production of electronics, household appliances, cars, etc.

In this paper, we confine ourselves to the issue of training specialists from scratch. We will answer to questions:

- How to build a systematic education of robotics in school?
- What electives and sections should be organized for this purpose?
- How to allocate time between training in robotics and teaching the basic compulsory subjects in school?

2. Problem Statement

The robotics industry faces the need to recruit high-skill workers. But what does it mean to be highly qualified for the robotics industry? What age is it best to start learning robotics? What topics and resources should be emphasized in training?

School robotics is represented by the following options:

1) Lego-kits simulating the assembly by ready-made instructions
2) Various ready-made robotic platforms that allow developing programming skills, for example, (Wyeth, 2008)
3) Specialized sections that conduct training on the basics of programming and the basics of electrical engineering, circuitry.

Based on the example of large robotic projects (Riadchykov et al, 2017a and 2017b), professional specialists in robotics can be conditionally divided into the following groups:

- Programmers
- Specialists in electrical engineering, designers
- Specialists in mathematical modeling
- Project Managers

Each type of professional specialty requires their own preparation, and accordingly the first stage of this training - the elements of professional training in the school. For example, it is quite normal, if the future specialist in the field of mathematical modeling in robotics, the initial acquaintance with robotics in the school years will limit only with options 1) and / or 2).

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3. Research Questions

We raise the issues of organizing early involvement (at school age) in robotics to improve the skills of the future employee in the field of robotics and attract talented students into the field. For the successful work/training in robotics at any age it is desirable to know mathematics, mechanics, physics, electrical engineering. It seems appropriate to organize the mutual integration of training robotics with teaching these disciplines. Certainly, acquaintance with robotics at a young age is useful for everyone. Only the degree of involvement of the student in robotics can be discussed. The student should be able to combine the study of robotics with the study of mathematics, physics, mechanics, electrical engineering. The degree of involvement is chosen depending on the preferences of the student. We examine what professional skills are required for each group of professional specialists in robotics, how they develop in the school period, how they will be affected by robotics in one form or another, and how to interact the training of robotics with teaching other fundamental disciplines (Kubilinskiene el a., 2017; Spolaôr & Benitti, 2017).

4. Purpose of the Study

The main purposes are:

- Implementation of modern scientific and practical technologies in the process of additional technical education.
- Assistance in the development of children's and youth's scientific and technical creativity. Promotion of achievements in the field of robotics and artificial intelligence.
- Build the foundations of information competence of the individual.
- Help the learner to master the methods of collecting and accumulating information, as well as technologies for its comprehension, processing and practical application.

It is common that on the basis of universities, for example, on the basis of the Kuban State University, study directions related to robotics are opened, where it is intended to use the project-oriented methodology of education and widespread use of simulator programs (Riadchykov et al, 2017c and 2017d). One of the challenges for the laboratory of robotics and mechatronics of Kuban State University is the organization of a system of sections for schoolchildren in order to prepare applicants for the selection and acquisition of a specialty with robotics. For the competent organization of such a system of sections, it is necessary to study the educational needs of students who connect their careers with robotics.

5. Research Methods

Robotics is an applied science engaged in the development of automated technical systems. Robotics relies on such disciplines as electronics, mechanics, programming. Training of students in robotics should fit into the program of additional education of children and youths in technical creativity. Basic knowledge in physics, mathematics and computer science can be visually demonstrated with the help of Lego-robots.

- Use of gaming technologies in teaching
- New forms of work with gifted children
- Developing the creative potential of students
- Popularization of the engineering and design- engineering
- Theoretical foundations of robotics

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- Physical fundamentals of robotics
- Information and information processes in modeling
- Designing
- Mobile robots. Microcomputers
- Algorithmization and logical control
- Psychological and pedagogical methods and features
- Methodological solutions for the teaching of robotics
- Curricula and work programs of disciplines.

Figure 1 illustrates the process of creating a robotic chassis by students of the robotics section of the Kuban State University. Figure 2 shows the final stage of creating a robotic chassis.

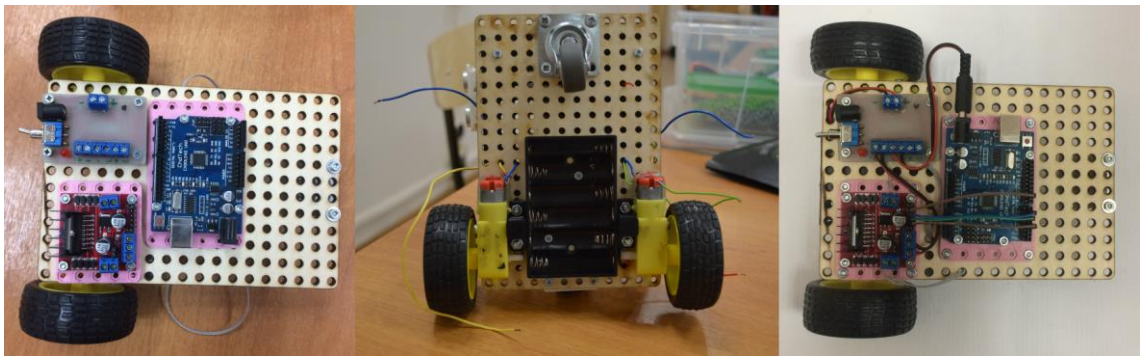

Figure 01. Development of a robotic chassis

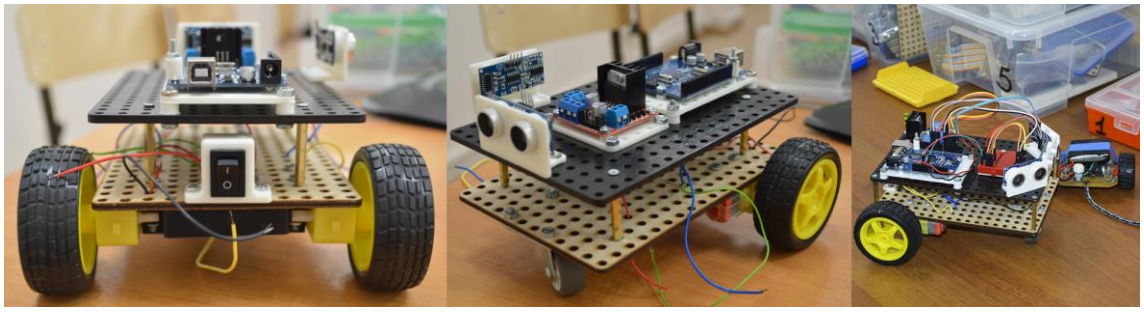

Figure 02. Robotic chassis. Final stages.

Some elements of the study of programming are interesting to combine with the study of programming history. For this you can use the legendary Soviet programmable calculator MK61 created in the eighties of the twentieth century.

Figure 03. Soviet programmable calculator MK61.

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6. Findings

Introduction to the elements of robotics at the school level, help all professionals involved in robotics. Moreover it is useful for any other professionals. However, for different categories of specialties, the optimal involvement in robotics is different. For example, for programmers, an "average" level of involvement in robotics is better suited, allowing them to engage (concentrate) also structural data and algorithms that are not directly used in robotics. Electrical engineers and designers benefit from more in-depth involvement in robotics at the school stage of training, but it will also be useful for them to concentrate on the school stage also with physics and mechanics. As for the specialists in mathematical modeling, then the excessive occupation in robotics at the school stage of training may have the opposite effect, since they need to leave the possibility for a fundamental study of mathematics, theoretical mechanics and other sciences. For future project managers, the most "high" level of involvement in robotics at the school stage of education is desirable, as they have to gain intuition, feel all the nuances and features of processes well. Moreover they have to gain experience of working in the team already at a young age, as well as guidance on other schoolchildren in school projects.

7. Conclusion

Based on the above, we can conclude that for the system development of the direction of robotics in a university it is necessary to create not only sections on robotics but also sections in mathematics, physics, computer science and work out a system of their mutual integration.

Breakthrough ideas in robotics will bring developers of new algorithms and new principles of device operation. It will rather be done by specialists with a broad and fundamental knowledge of the exact sciences, such as mathematics, mechanics and physics. The preparation of such specialists from a young age must be associated with an in-depth study of precisely these disciplines, regardless of the binding to robotics.

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